The Functionality of Legume-Grass Swards in a Long-Term Pasture: Productivity and Stability

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The functionality of legume-grass swards in a long-term pasture: productivity and stability

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Introduction

Combinations of various plant species or functional groups can enhance sward structure, the function and stability of an ecosystem, supplement forage production and mitigate negative environmental impacts. Climatic variation, rising temperatures, changing precipitation and other extreme climatic events may lead to changes in plant diversity (Soussana and Lüscher 2007). At the same time it is very important to optimise functional diversity by combining species with different properties that are well adapted to the local environments (Huyghe *et al*. 2012). Successful selection and management of legumes influences the herbage production, nutritional quality and sustainability of grazing systems. Therefore, their role is very important in ecosystem and livestock production systems. A grass-legume system confers benefits to the grass, especially in the early life of sown mixtures (Rochon *et al*. 2004; Nyfeler *et al*. 2009), and it is very important to identify the contribution of each species to performance in the mixtures (Parsons *et al*. 2011).

The objectives of this study were to assess the ability of legume-based swards to produce more stable herbage yields over several years under grazing without nitrogen fertilization and to estimate the persistence of swards.

Materials and methods

A field experiment was conducted at 1998 on a gleyic loamy Endocalcari-Epihypogleyic Cambisol in Lithuania (55°24'N, 23°50'E). The soil pH(KCL) varied from 6.5-7.0, humus content was 2.5-3.2%, available P was 50-80 mg/kg and K was 100-150 mg/kg of soil. The following 7 mixtures were sown: (1) *Trifolium repens* L. (white clover) *and Lolium perenne* L. (perennial ryegrass) (*Tr/Lp*); (2) white clover, perennial ryegrass and *Poa pratensis* L. (smooth-stalked meadow grass) (*Tr/Lp/Pp*); (3) *Medicago sativa* L. (lucerne), perennial ryegrass and smooth-stalked meadow grass (*Ms/Lp/Pp*); (4) white clover, lucerne and perennial ryegrass (*Tr/Ms/Lp*); (5) perennial ryegrass without nitrogen fertilization (*Lp*/N0); (6) perennial ryegrass fertilized with 240 N kg/ha/yr (*Lp*/N240); and (7) white clover and *Festulolium* hybrid (*Tr/F*). The legume/grass ratio was 40:60 (swards with white clover) and 60:40 (swards containing lucerne). The trial design was a randomized block design with 4 replicates. Plot size was 18.75 m^2. All swards received 26 P kg/ha and 50 K kg/ha in early spring. The *Lp*/N240 treatment received 60 N kg/ha in spring and after the first, second and third grazing. The grazing period lasted from the beginning of May until mid October each year, with 4-5 grazings at 25-40 day intervals. The experimental data were statistically processed using ANOVA at significance level of $P<0.05$.

Results

Marked changes occurred in species and functional group composition within swards over the 12 years. Averaged over the experimental period, total sward dry matter (DM) was 4.85 t /ha and in the years most favourable for the growth of perennial grasses, it was as high as 8-9 t (data not presented). DM yield of all swards decreased considerably from the first year (1999) to the last year (2010) (Table 1). The weather conditions differed considerably between the

Table 1. Annual DM yield (t/ha) of legumes (L), grasses (G), forbs (F) and sward totals (S) over 12 years.

Swards	1999				2010				Mean of 12 yrs			
	L	G	F	S	L	G	F	S	L	G	F	S
Tr/*Lp*	2.99	2.96	0.10	6.12	0.34	0.77	2.09	3.20	1.13	1.61	1.44	4.18
Tr/*Lp*/*Pp*	3.48	3.07	0.08	6.56	0.38	0.61	2.03	3.03	1.19	1.61	1.31	4.11
Ms/*Lp*/*Pp*	5.25	2.19	0.13	7.55	0.72	0.81	2.42	4.01	3.58	1.22	1.30	6.10
Tr/*Ms*/*Lp*	4.04	2.81	0.12	6.96	0.41	0.82	2.21	3.72	2.62	1.61	1.50	5.73
Lp/N0	0.14	3.04	0.05	3.23	0.33	0.91	3.97	3.44	0.91	1.74	1.31	3.96
Lp/N240	0.04	7.45	0.06	7.54	0.07	1.44	1.83	5.48	0.19	2.82	2.58	5.59
Tr/*F*	2.40	4.27	0.07	6.74	0.27	0.87	2.09	2.98	1.06	1.79	1.44	4.29
LSD($P<0.05$)	0.370	0.378	0.018	0.511	0.101	0.065	0.327	0.295	0.147	0.136	0.153	0.329

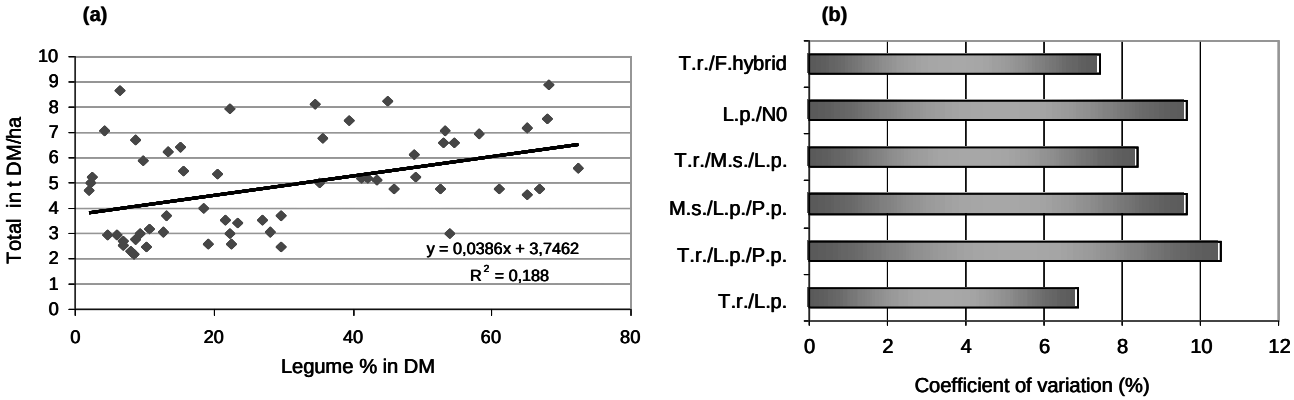

Figure 1. (a) The relationship between annual DM yield and legume proportion in swards; and (b) the inter-annual coefficient of variation in swards.

seasons for both rainfall and temperature. The yield of legumes in the mixtures fluctuated between years, in response to differences in rainfall and temperature, and was strongly influenced by environmental stress, particularly dry seasons. Legume species and their persistence had a major impact on sward composition and total yield, with lucerne-based swards performing best. In the year of sowing, sown species dominated and only traces of forbs were found, but by the 12th year forbs accounted for 60-70% of swards.

Total sward yields were positively influenced by the proportion of legumes during the experiment, although not as markedly as expected (Fig. 1a). The proportion of legumes differed between years, with the content of white clover being particularly low in dry years. However, the inter-annual coefficients of variation for swards were comparatively low in all swards. The analysis of herbage yield variability did not show a very clear positive influence of white clover or lucerne mixtures on yield stability (Fig. 1b).

Conclusions

Significant changes occurred in the sward composition over the 12-year experimental period and the yield differences were marked. The legume proportion in the different swards fluctuated between years. However, the proportion of legumes, especially lucerne, had a substantial positive effect on annual herbage yield. The prevalence of forbs of after more than ten years of swards use shows the necessity pasture re-establishment.

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